# GE PTCC YTCC Thermocouple Input Modules

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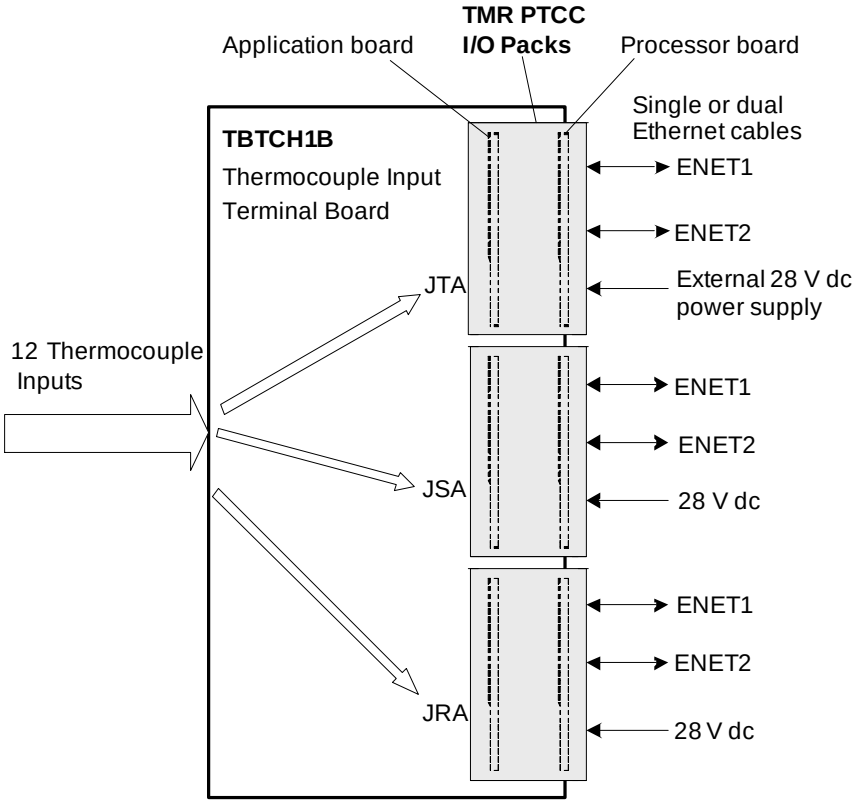
# 16 GE PTCC, YTCC Thermocouple InputModules

## 16.1 Mark Vle PTCC Thermocouple Input Pack


The Thermocouple Input PTCC provides the electrical interface between one or two I/O Ethernet networks (IONet) and a thermocouple input terminal board. The I/O pack contains a BPPx processor board and an acquisition board specific to the thermocouple input function. Input to the PTCC is through dual RJ-45 Ethernet connectors and a three-pin power input. Output is through a DC-37 pin connector that mates directly with the associated terminal board connector. Visual diagnostics are provided through indicator LEDs.

In a simplex configuration using the TBTCH1C terminal board, each PTCC is capable of handling up to 12 thermocouple inputs, for a total of 24 inputs (with two of them). In simplex configuration using the TBTCH1B terminal board, each PTCC is capable of handling up to 12 thermocouple inputs (for a total of 24 inputs), provided the two PTCCs are installed at the JRA and JTB connectors. In TMR configuration with the TBTCH1B, three PTCCs are used with three cold junctions, but only 12 thermocouples are available.



### 16.1.1 Compatibility

The PTCC includes one of the following compatible processor boards:

- PTCCH1A and H2A contain a BPPB processor board
- PTCCH1B and H2B contains a functionally compatible BPPC processor board that is supported in the ControlST***** software suite V04.06 and later

The PTCC is available in the following two versions:

- PTCCH1A and PTCCH1B support E, J, K, S, and T types of standard thermocouples and mV inputs. The mV span is –8 to 45 mV.
- PTCCH2A and H2B support E, J, K, S, T, B, N, and R types of standard thermocouples and mV inputs. The mV span for PTCCH2 is –20 to 95 mV.

***Attention***

**B, N and R types of thermocouples should only be selected if PTCCH2A or PTCCH2B is used. These types of thermocouples must not be used or selected with PTCCH1A or PTCCH1B I/O packs.**

The PTCC is compatible with the thermocouple input terminal board TBTC, and the simplex STTC terminal board, but not the DIN-rail mounted DTTC board. The following table provides the details of the terminal board compatibility.

| Terminal Board | Configuration | # Packs | Thermocouple Inputs | Connectors |
|---|---|---|---|---|
| TBTCH1B, S1B | Simplex | 1 | 12 | Any |
| | | 2 | 24† | JRA and JTB |
| | TMR | 3 | 12 | JRA, JSA, JTA |
| TBTCH1C, S1C | Simplex | 1 or 2 | 12 or 24 | JA1, JB1 |
| STTCH1A, S1A, H2A, S2A | Simplex | 1 | 12 | JA1 |
| † Support of 24 thermocouple inputs on the TBTC_1B in simplex configuration requires the use of two PTCC I/O packs, which must be connected to JRA and JTB. | | | | |

## 16.1.2 Installation

➢ **To install the PTCC**

1. Securely mount the desired terminal board.
2. Directly plug the PTCC into the terminal board connectors.
3. Mechanically secure the PTTC(s) using the threaded studs adjacent to the Ethernet ports. The studs slide into a mounting bracket specific to the terminal board type. The bracket location should be adjusted such that there is no right-angle force applied to the DC-37 connector between the PTCC and the terminal board. The adjustment should only be required once in the service life of the product.

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***Note*** The PTCC mounts directly to a Mark* VIe terminal board. Simplex terminal boards (TBTCH1C) have two DC-37 pin connectors that receive the PTCC, one for each set of 12 TC inputs. TMR capable terminal boards (TBTCH1B) have six DC-37 pin connectors. The PTCC directly supports all of these connections.

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4. Plug in one or two Ethernet cables depending on the system configuration. The PTCC will operate over either port. If dual connections are used, the standard practice is to connect ENET1 to the network associated with the R controller.
5. Apply power by plugging in the connector on the side of the PTCC. It is not necessary to remove power from the cable before plugging it in because the PTCC has inherent soft-start capability that controls current inrush on power application.
6. Use the ToolboxST* application to configure the PTCC as necessary.

## 16.1.3 Operation

The following features are common to the distributed I/O modules:

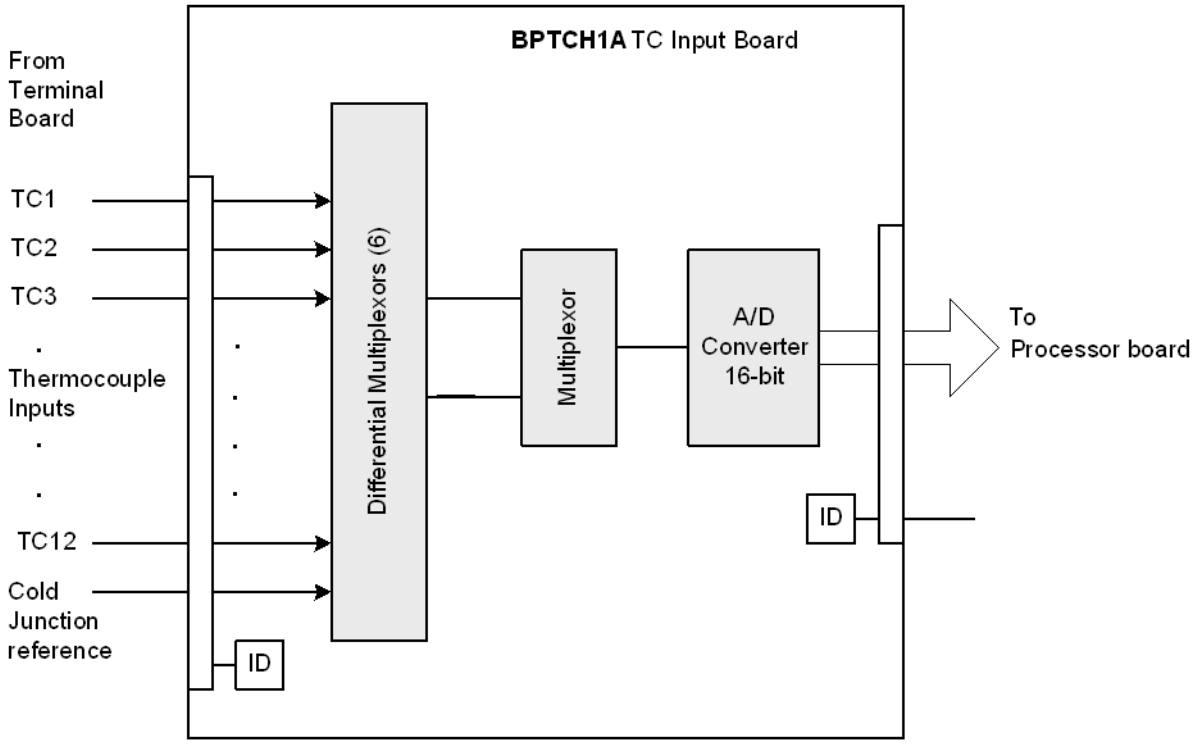
- *BPPx Processor*
- *Processor LEDs*
- *Power Management*
- *ID Line*
- *I/O Module Common Diagnostic Alarms*

### 16.1.3.1 Analog Input Hardware

The PTCC internal input board (BPTC) accepts 12 signals at mV levels from the thermocouples wired to the terminal board. The analog input section consists of six differential multiplexers, a main multiplexer, and a 16-bit analog to digital converter that sends the digital data to the adjacent processor board. Each input has hardware and firmware filters, and the converter samples at up to 120 Hz.

Type E, J, K, S, and T thermocouples can be used with PTCCH1A, and they can be grounded or ungrounded. Type E, J, K, S, T, B, N and R thermocouples can be used with PTCCH2A, and they can be grounded or ungrounded. Thermocouples can be located up to 300 meters (984 feet) from the turbine I/O panel with a maximum two-way cable resistance of 450 Ω.

Linearization for individual thermocouple types is performed in software by the I/O pack board. A thermocouple, which is determined to be out of the hardware limits, is removed from the scanned inputs to prevent adverse effects on other input channels. If two I/O packs are used, and both Cold Junction (CJ) devices are within the configurable limits, then the average of the two is used for CJ compensation.



### 16.1.3.2 Thermocouple Limits

**TBTC with PTCCH1**

Thermocouple inputs support a full-scale input range of –8.0 mV to 45.0 mV. The following table displays typical input voltages for different thermocouple types versus the minimum and maximum temperature range. The CJ temperature is assumed to range from –30 to 65°C (–22 to 149 °F). The units (°C or °F) are based on the *ThermCplUnit* parameter.

***TC Limits for I/O Pack Type PTCCH1***

| Item | Thermocouple Type | | | | |
|---|---|---|---|---|---|
| | E | J | K | S | T |
| Low range, °F | -60 | -60 | -60 | 0 | -60 |
| Low range, °C | -51 | -51 | -51 | -17.78 | -51 |
| mV at low range with reference at 70°C (158 °F) | -7.174 | -6.132 | -4.779 | -0.524 | -4.764 |
| High range, °F | 1100 | 1400 | 2000 | 3200 | 750 |
| High range, °C | 593 | 760 | 1093 | 1760 | 399 |
| mV at high range with reference at 0°C (32 °F) | 44.547 | 42.922 | 44.856 | 18.612 | 20.801 |

**TBTC with PTCCH2**

Thermocouple inputs support a full-scale input range of -20.0 mV to 95.0 mV. The following table displays typical input voltages for different thermocouple types versus the minimum and maximum temperature range. The CJ temperature is assumed to range from -30 to 65°C (-22 to 149 °F).

***TC Limits for I/O Pack Type PTCCH2***

| Item | Thermocouple Type | | | | |
|---|---|---|---|---|---|
| | E | J | K | S | T |
| Low range, °F | -60 | -60 | -60 | 0 | -60 |
| Low range, °C | -51 | -51 | -51 | -17.78 | -51 |
| mV at low range with reference at 70°C (158 °F) | -7.174 | -6.132 | -4.779 | -0.524 | -4.764 |
| High range, °F | 1832 | 2192 | 2372 | 3200 | 752 |
| High range, °C | 1000 | 1200 | 1300 | 1760 | 400 |
| mV at high range with reference at 0°C (32 °F) | 76.373 | 69.553 | 52.41 | 18.612 | 20.869 |

***TC Limits for I/O Pack Type PTCCH2***

| Item | Thermocouple Type | | |
|---|---|---|---|
| | B | N | R |
| Low range, °F | 32 | -60 | 0 |
| Low range, °C | 0 | -51 | -17.78 |
| mV at low range with reference at 70°C (158 °F) | -0.0114 | -3.195 | -0.512 |
| High range, °F | 3272 | 2282 | 3092 |
| High range, °C | 1800 | 1250 | 1700 |
| mV at high range with reference at 0°C (32 °F) | 13.593 | 45.694 | 20.220 |

#### 16.1.3.3 Cold Junctions

The CJ signal goes into signal space and is available for monitoring. Acceptable limits are configured, and if a CJ goes outside the limit, a logic signal is set. A 1 °F error in the CJ compensation will cause a 1 °F error in the thermocouple reading.

Hard-coded limits are set at -50 to 85°C (-58 to 185 ºF), and if a CJ goes outside this, it is regarded as unhealthy. Most CJ failures are open or short circuit. If the CJ is declared bad, the backup value (CJBackup, an output variable sent from the controller) is used. This backup value can be derived from CJ readings on other terminal boards, or can be the configured default value. The units (°C or °F) are based on the *ColdJuncUnit* parameter.

### 16.1.4 PTCC Specifications

| Item | PTCC Specification |
|---|---|
| Number of Channels | 12 channels per I/O pack |
| Thermocouple Types | E, J, K, S, T thermocouples, and mV inputs for PTCCH1.<br>E, J, K, S, T, B, N, R thermocouples, and mV inputs for PTCCH2.<br>***B, N and R types of thermocouples should only be selected with PTCCH2A or PTCCH2B.*** |
| Span | -8 mV to 45 mV for PTCCH1<br>-20 mV to 95 mV for PTCCH2 |
| A/D Converter | Sampling type 16-bit A/D converter |
| Cold Junction Compensation | Reference junction temperature measured in each module<br>TMR board has three cold junction references |
| Cold Junction Temperature Accuracy | Over the Celsius operating range: 1.1°C<br>Over the Fahrenheit operating range: 2 °F |
| Conformity Error | Maximum software error 0.14ºC (0.25 ºF) |
| Measurement Accuracy | PTCCH1 = 53 µV (excluding cold junction reading).<br>Example: For type K, at 1000 °F, including cold junction contribution,<br>RSS error= 3 °F<br>PTCCH2 = 115 µV (excluding cold junction reading).<br>Example: For type K, at 1000 °F, including cold junction contribution,<br>RSS error= 6 °F |
| Common Mode Rejection | AC common mode rejection 110 dB at 50/60 Hz, for balanced impedance input. Both hardware and firmware filtering. |
| Common Mode Voltage | ±5 Volts |
| Normal Mode Rejection | Rejection of 250 mV rms at 50/60 Hz, ±5%,<br>Both hardware and firmware filtering provides a total of 80 dB NMRR |
| Scan Time | All inputs are sampled at up to 120 times per second per input |
| Fault Detection | High/low (hardware) limit check<br>High/low system (software) limit check<br>Monitor readings from all TCs, CJs, calibration voltages, and calibration zero readings |
| Ambient Rating for Enclosure Design† | PTCCH1B is rated from -40 to 70°C (-40 to 158 °F)<br>PTCCH1A is rated from -30 to 65°C (-22 to 149 °F) |

***Note*** † For further details, refer to the *Mark VIe and Mark VIeS Control Systems Volume I: System Guide* (GEH-6721_Vol_I), the chapter *Technical Regulations, Standards, and Environments*.

## 16.1.5 Diagnostics

The I/O pack performs the following self-diagnostic tests:

- A power-up self-test that includes checks of RAM, flash memory, Ethernet ports, and processor board hardware
- Continuous monitoring of the internal power supplies for correct operation
- A check of the electronic ID information from the terminal board, acquisition board, and processor board to confirm that the hardware set matches, followed by a check that the application code loaded from flash memory is correct for the hardware set

Details of the individual diagnostics are available in the ToolboxST application. The diagnostic signals can be individually latched, and then reset with the RESET_DIA signal if they go healthy.

## 16.1.6 Configuration

### 16.1.6.1 Parameters

| Parameter | Description | Choices |
|---|---|---|
| SysFreq | System Frequency (used for noise rejection) | 60 Hz, 50 Hz |
| SystemLimits | Allows user to temporarily disable all system limit checks for testing purposes. Setting this parameter to Disable will cause a diagnostic alarm to occur. | Enable (default), Disable |
| AutoReset | Automatic restoring of thermocouples removed from scan | Disable, Enable |

### 16.1.6.2 Thermocouples

| Thermocouple Name | Thermocouple Description | Choices |
|---|---|---|
| Thermocouple01 | First of 24 thermocouples, point signal | Point Edit (Input FLOAT) |
| Thermocouple12 | | |
| ThermCplType | Select thermocouples type or mV input.<br><br>Unused inputs are removed from scanning. The mV inputs are primarily for maintenance, but can also be used for custom remote CJ compensation. Standard remote CJ compensation is also available. | PTCCH1– Unused, mV, T, K, J, E, or S<br>PTCCH2 – Unused, mV, T, K, J, E, S, B, N, or R<br><br>B, N and R types of thermocouples should only be selected if PTCCH2A or PTCCH2B is used. |

| Thermocouple Name | Thermocouple Description | Choices |
|---|---|---|
| ThermCplUnit | Select thermocouples display unit in °C or °F. This value needs to match units of attached variable. The ThermCplUnit parameter affects the native units of the controller application variable. It is only indirectly related to the tray icon and associated unit switching capability of the HMI. This parameter should not be used to switch the display units of the HMI. | deg_F, deg_C |
| |  **Caution** **Do not change the ThermCplUnit parameter because these changes will require corresponding changes to application code and to the Format Specifications or units of the connected variable. This parameter modifies the actual value sent to the controller as seen by application code. Application code that is written to expect degrees Fahrenheit will not work correctly if this setting is changed. External devices, such as HMIs and Historians, may also be affected by changes to this parameter.** | |
| ReportOpenTC | For PTCCH2 version only; this parameter sets the failed state of an open thermocouple to either hot (high) or cold (low).<br><br>This parameter is not applicable to the PTCCH1 version. | Fail_Cold, Fail_Hot |
| LowPassFiltr | Enable 2 Hz low pass filter | Enable, Disable |
| SysLimit1 | System Limit 1 in °C, °F, or mV | -450 to 3500 (FLOAT) |
| SysLim1Enabl | Enable system limit 1 fault check, a temperature limit which can be used to create an alarm. | Enable, Disable |
| SysLim1Latch | Latch system limit 1 fault<br>Determines whether the limit condition will latch or unlatch; reset used to unlatch | NotLatch, Latch |
| SysLim1Type | System limit 1 check type limit occurs when the temperature is greater than or equal (≥), or less than or equal to (≤) a preset value | ≥ or ≤ |
| SysLimit2 | System Limit 2 in °C, °F, or mV | -450 to 3500 (FLOAT) |
| SysLim2Enabl | Enable system limit 2 fault check,<br>a temperature limit which can be used to create an alarm. | Enable,<br>Disable |
| SysLim2Latch | Latch system limit 2 fault<br>Determines whether the limit condition will latch or unlatch; reset used to unlatch<br>System limit 2 check type limit occurs when the temperature is greater than or equal (≥), or less than or equal to (≤) a preset value | NotLatch, Latch |

| Thermocouple Name | Thermocouple Description | Choices |
|---|---|---|
| SysLim2Type | System limit 2 check type limit occurs when the temperature is greater than or equal (≥), or less than or equal to (≤), a preset value. | ≥ or ≤ |
| TMR_DiffLimt | Diagnostic limit, TMR input vote difference in engineering units Limit condition occurs if three temperatures in R, S, T differ by more than a preset value (engineering units); this creates a voting alarm condition. | -450 to 3500 (FLOAT) |

### *16.1.6.3 Cold Junctions*

Cold junctions are similar to thermocouples but without low pass filters.

| Cold Junction Name | Cold Junction Description | Choices |
|---|---|---|
| ColdJuncType | Select CJ Type | Remote, Local |
| ColdJuncUnit | Select TC Display Unit Deg °C or °F. Value needs to match units of attached variable | Deg_F, Deg_C |
| SysLimit1 | System Limit 1 - Deg °F or Deg °C | -40 to 185 (FLOAT) |
| SysLim1Enabl | Enable System Limit 1 Fault Check | Disable, Enable |
| SysLim1Latch | Latch System Limit 1 Fault | NotLatch, Latch |
| SysLim1Type | System Limit 1 Check Type (≥ or ≤) | ≥ or ≤ |
| SysLimit2 | System Limit 2 - Deg °F or Deg °C | -40 to 185 (FLOAT) |
| SysLim2Enabl | Enable System Limit 2 Fault Check | Disable, Enable |
| SysLim2Latch | Latch System Limit 2 Fault | NotLatch, Latch |
| SysLim2Type | System Limit 2 Check Type (≥ or ≤) | ≥ or ≤ |
| TMR_DiffLimt | Diag Limit, TMR Input Vote Difference, in Eng Units | -450 to 3500 (FLOAT) |

### *16.1.6.4 Variables*

| Variable | Description | Direction | Type |
|---|---|---|---|
| L3DIAG_PTCC | I/O Diagnostic Indication | Input | BIT |
| LINK_OK_PTCC | I/O Link Okay Indication | Input | BIT |
| ATTN_PTCC | I/O Attention Indication | Input | BIT |
| PS18V_PTCC | I/O 18 V Power Supply Indication | Input | BIT |
| PS28V_PTCC | I/O 28 V Power Supply Indication | Input | BIT |
| IOPackTmpr | I/O Pack Temperature (deg °F) | AnalogInput | FLOAT |
| SysLim1TC1 | System limit 1 for thermocouple 1 | Input | BIT |
| ↓ | ↓ | ↓ | |
| SysLim1TC12 | System limit 1 for thermocouple 12 | Input | BIT |
| SysLim1CJ1 | System limit 1 for cold junction 1 | Input | BIT |
| SysLim2TC1 | System limit 2 for thermocouple 1 | Input | BIT |
| ↓ | ↓ | ↓ | |
| SysLim2TC12 | System limit 2 for thermocouple 12 | Input | BIT |
| SysLim2CJ1 | System limit 2 for cold junction 1 | Input | BIT |
| CJBackup | Backup Cold Junction Temperature (°F or °C based on Cold Junction configuration) | AnalogOutput | FLOAT |
| CJRemote1 | Remote Cold Junction Temperature. Used when Cold Junction set to Remote (°F or °C based on Cold Junction configuration) | AnalogOutput | FLOAT |

# 16.2 PTCC Specific Alarms

The following alarms are specific to the PTCC I/O pack.

## 32-43

**Description** Thermocouple [ ] input voltage exceeds HW limit ([ ])

### Possible Cause

- Thermocouple millivolt input to the analog-to-digital converter exceeded the converter limits and will be removed from the scan.

### Solution

- Check field wiring, including shields.
- Check installation of the I/O pack on the terminal board. Problem is usually not a I/O pack or terminal board failure if other thermocouples are working correctly.

## 80

**Description** Cold Junction [ ] input voltage exceeds HW limit ([ ])

**Possible Cause** Cold junction input to the analog-to-digital converter exceeded the limits of the converter. If a cold junctions fails, the **CJ_Backup** value is used.

### Solution

- Check the mounting of the I/O pack on the terminal board.
- Replace the terminal board.
- Replace the I/O pack.

## 92-103

**Description** Thermocouple [ ] value beyond range of configured TC type ([ ] deg)

**Possible Cause**

- Thermocouple mV input exceeded range of linearization (lookup) table for this TC type. Refer to documentation for specified thermocouple ranges.
- Thermocouple configured as wrong type.
- Board detected a thermocouple open, applied bias to circuit, driving it to a large negative number.
- Stray voltage or noise caused the input to exceed its range.

**Solution**

- Check field wiring, including shields.
- Check thermocouple for open circuit.
- Verify that the thermocouple type matches the configuration.
- Measure incoming mV signal and verify that it is within the specified thermocouple range.

## 128

**Description** Logic Signal [ ] Voting Mismatch

**Possible Cause** N/A

**Solution** N/A

## 160

**Description** Internal pack power supply not OK.

**Possible Cause** A power supply internal to the pack is not working properly. All thermocouple readings are suspect.

**Solution** Replace the I/O pack.

## 161

**Description** Reference Voltage out of limits

**Possible Cause** The reference voltage for the inputs is more than +/-5% beyond the expected value, indicating hardware failure.

**Solution** Replace the I/O pack.

## 163

**Description** Null Voltage out of limits

**Possible Cause** The Null voltage for the inputs is more than +/-5% beyond the expected value, indicating hardware failure.

**Solution** Replace the I/O pack.

## *224-236*

**Description** Input Signal [ ] Voting Mismatch, Local=[ ], Voted=[ ]

### Possible Cause

- The specified input signal varies from the voted value of the signal by more than the **TMR_DiffLimt**.
- A problem exists with the input, either from the device, the wire to the terminal board, or the terminal board.

### Solution

- Verify that **TMR_DiffLimt** is set to the proper value.
- Check the grounding of the connected inputs and terminal board.
- Reboot the I/O pack.
- Replace the I/O pack.
- Replace the terminal board.